height of the air bearing surface of the head. Indeed, the flying behavior of the air bearing surface can become unstable if the head moves too far into the roll-off region of the disc, which can result in contact between the head and the disc surface. Any contact between the head and the disc surface may result in damage to the disc or head, leading to early disc drive mechanical failure.

[0009] Accordingly, it is important to design the disc drive such that the outer diameter of the data track band is spaced suitably inward from any portion of the disc roll-off region where fly height degradation can occur when reading data from or writing data to data tracks arranged at the outer diameter of the data track band. However, it is desirable that each disc used in a disc drive have a maximum radius relevant to the roll-off region that is equal to or greater than a preselected threshold radius so as to not impact the radial extent of the data track band beyond an acceptable amount.

[0010] To that end, during the manufacture of magnetic discs that are to be used in a disc drive, a check should be made of the roll-off radius of each disc as it moves through the manufacturing process, so as to reject any disc having a roll-off radius less than the preselected threshold value. In this manner, each disc made available for assembly into a disc drive will be able to accommodate a maximum data track band width for a maximized data capacity for the drive, without undesirable fly height instability or lack of clearance in the separation of recording head and media at the data tracks near the outer diameter of the data track band.

[0011] In a hard disc drive, certain clearance in the separation of recording head and media is required to avoid contacts and unstable flight at high rotation speed. Glide avalanche test is the common methodology used in the disc drive industry to monitor the spacing clearance U.S. Patent No. 5,410,439. Outer Diameter Glide Avalanche (OD GA) has become an important gauge in qualifying media in recent years as a result of the requirements for low glide avalanche and high utilization of the disc surface. Performance of OD GA is affected by the disc edge roll-off. Thus, the problem of accurately measuring disc roll-off remains.

[0012] Conventional technique utilizes a contact profiler, such as Tencor P12, to measure disc topography in the radial direction near the edge of the disc. The dub-off and/or chord height computed from the measured trace is then reported. The dub-off

value is defined as the maximum height undulation between two radii of the disc at the outer diameter. However, it has been determined that the dub-off value does not provide adequate information regarding fly height stability for a head positioned at a data track near or at the outer diameter of the data track band. In fact, there is a poor correlation between the dub-off value and fly height performance. Accordingly, the presently known disc measurement procedures do not provide an adequate system or process for achieving a reliable quality control for discs relevant to maximizing data capacity by assuring compliance by each disc with a maximum data band width having fly height stability at the outer diameter of the band.

[0013] A method using slope difference between lateral distances of a head width was suggested to improve the accuracy U.S. Patent No. 5,497,085. However, the algorithm in that patent is still based upon displacement measurements on limited locations, which suffers in both sensitivity and variation of the measurement. The choice of differentiating slopes in the distance of head width limits the lateral resolution of this method, which cannot provide an effective inspection of the maximum available radius in meeting the disc specifications.

SUMMARY OF THE INVENTION

[0014] The present invention provides an efficient and accurate method for determining outer diameter roll-off characteristics for a magnetic disc that provide information relevant to fly height stability.

[0015] A related objective is to provide a method of classifying discs into related groups based on their roll-off characteristics.

[0016] According to the present invention, profile information is developed using radial curvature, based on slope measurements on a rotating disc to monitor the edge profile and predict OD GA performance. According to the present method, in the first step using a slope scan type of instrument, the radial slopes of N radial lines on the disc, which may be subdivided into M circumferential tracks around each disc, are measured. As a next step, the measured slopes of the same circumferential track are averaged for all tracks. As a next step, the radial moving average for the track slopes is then determined, before any derivate is taken. The length of each moving average is

chosen to eliminate spikes due to the differentiation, and still maintain a lateral resolution that is much smaller than the width of the head. Then finally, the radial derivative is taken, building a curvature profile from the raw data of slope changes.

[0017] By following these steps, a manufacturing specification can be set at the radius where the curvature profile begins to rise up from zero which would be the point at which the roll off would be sufficiently significant that the spacing between the head and the track surface would become unstable.

[0018] The present invention can be implemented in a disc manufacturing process to insure that each disc passing through the manufacturing process has an acceptable outer diameter roll-off value that accommodates stable fly height at the outer data tracks of a maximized data track band width. Further, the method could be used to classify the discs into groups, each group having the same or similar roll-off characteristic to meet a manufacturer's design goals or specifications.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Fig. 1 is a perspective view of a disc drive in which discs evaluated using this method are useful.

[0020] Fig. 2 is an exaggerated view of a portion of one disc showing the tracks and the actuator used to read them.

[0021] Figs. 3A and 3B each depict an exploded view of the radially outer end of the disc of Fig. 2, including the head and slider at a fly height of the surface of the disc.

[0022] Fig. 4 is a very simplified block diagram of an exemplary quality control disc test system according to present invention.

[0023] Fig. 5A and 5B are schematics of a disc and the use of a profilometer to generate data used to develop a curvature profile of the disc.

[0024] Fig. 6 is a flowchart of the data processing algorithm used to develop the curvature profile according to the present invention.

[0025] Fig. 7A and 7B are figures used to illustrate the correlation between OD glide avalanche and OD curvature profiles for a set of discs.

[0026] Fig. 8 is a table of glide avalanche data for a plurality of cells of discs.